Biological Survey of Pacific Hake, Walleye Pollock and Spiny Dogfish in the Strait of Georgia. *R/V G.B. Reed*, March 19–30, 1984

W. Shaw, G. A. McFarlane, and S. E. MacLellan

Department of Fisheries and Oceans
Fisheries Research Branch
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

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BIOLOGICAL SURVEY OF PACIFIC HAKE, WALLEYE POLLOCK AND SPINY DOGFISH IN THE STRAIT OF GEORGIA. R/V G.B. REED, MARCH 19-30, 1984

by

W. Shaw, G. A. McFarlane, and S. E. MacLellan

Department of Fisheries and Oceans

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ABSTRACT

Shaw, W., G. A. McFarlane, and S. E. MacLellan. 1986. Biological survey of Pacific hake, walleye pollock, and spiny dogfish in the Strait of Georgia. R/V G.B. REED, March 19-30, 1984. Can. Data Rep. Fish. Aquat. Sci. 590: 95 p.

A total of 26 midwater trawls were completed in the Strait of Georgia. The majority of the tows were made deeper than 135 m (74 fath). Pacific hake accounted for 44.2% of the total catch of all species. Modal length of hake was 40-41 cm. Age 5+ and 6+ fish dominated the age composition representing the strong 1978 and 1979 year-classes. Length at 50% maturity for males was 30.0 cm and 33.9 cm for females. Walleye pollock accounted for 33.2% of the total catch of all species. Modal length of pollock was 40 cm. Sixty-one percent of the males and 11% of the females were ripe and running. The length at 50% maturity was 29.5 cm for males and 30.0 cm for females. Spiny dogfish accounted for 22.2% of the total catch of all species. Sixty-three percent of the dogfish were <60 cm. Most of these fish were caught off Cape Lazo. Dogfish >60 cm were mostly caught off Halibut Bank. Fifty-nine percent of the dogfish were immature.

Key words: Pacific hake, walleye pollock, spiny dogfish, biology, Strait of Georgia

RESUME

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Vingt-six chalutages pélagiques, la majorité à plus de 135 m (74 brasses), ont été effectués dans le détroit de Géorgie. Le merlu du Pacifique représentait 44,2 % de l'ensemble des prises de toutes les espèces. La longueur modale des merlus était de 40-41 cm. Les poissons d'âges 5+ et 6+, représentant les classes de 1978 et 1979, dominaient la distribution des âges. La longueur à 50 % de maturité était de 30,0 cm pour les mâles et de 33,9 cm pour les femelles. La morue du Pacifique représentait 33,2 % des prises. La longueur modale de ces poissons était de 40 cm, et 61 % des mâles et 11 % des femelles étaient matures et en traine de frayer. La longueur à 50 % de maturité était de 29,5 cm pour les mâles et de 30,0 cm pour les femelles. L'aiguillat commun représentait 22,2 % de l'emsemble des prises et 63 % des poissons mesuraient 60 cm ou moins. La majorité des aiguillats ont été capturés au large du cap Lazo. Les poissons de plus de 60 cm ont été pêchés au large du banc Halibut. En tout, 59 % des aiguillats étaient immatures.

Mots clés: Merlu du Pacifique, morue du Pacifique, aiguillat commun, biologie, détroit de Géorgie

INTRODUCTION

The biological survey conducted during March 1984 is part of an on-going study of Pacific hake (Merluccius productus) and walleye pollock (Theragra chalcogramma) stocks in the Strait of Georgia. The primary purpose of this survey was to monitor the spawning concentrations of Pacific hake in the Strait of Georgia. At the same time biological data for spiny dogfish (Squalus acanthias) was collected.

This report presents set information and summarizes the results of the catch composition and biological studies.

METHODS AND MATERIALS

The R/V G.B. REED was used during the survey. All fishing was conducted with a midwater Diamond 5-B trawl equipped with a 4.0 cm (1.6 in) mesh herring codend. Attached to the headline of the net was an ELAC model LAZ 17 headrope transducer. The vessel's Simrad EK 38A echosounder was used for echosounding the 1983 survey tracklines (Shaw et al. 1985). Additional tracklines were included during this survey to define the distribution of the concentration layer around E. Mayne Island area. Set locations were distributed throughout the Strait and were positioned in areas where concentrations of fish were seen on the echogram. Tows were made to identify the species composition in the various midwater concentration layers. The catch from each set was sorted by species into 55L (12 gal) galvanized tubs and weighed to the nearest kilogram using a platform balance. Small catches were sampled in their entirety while a subsample was collected from larger catches according to the methods of Westrheim (1967).

Hake and pollock were measured for fork length and sexed. Either the total catch or random samples of tubs filled with hake or pollock were examined for maturity states (Weir et al. 1978) and stomach contents. Individual weights of hake, from stratified samples, were recorded using a Digimetric 30 DTI top-load electronic balance equipped with a digital integrator. Paired otoliths from hake and left pectoral fins from pollock were collected for age. Age determination procedures for otoliths and pectoral fin rays are outlined in Beamish (1979) and (1981), respectively. The stomach contents from hake and pollock were identified if possible and a visual estimate of its volume (cc) was made. All dogfish were sexed and measured for total length from the tip of the snout to the tip of the upper lobe of the caudal fin when depressed in a line horizontal to the body. Dogfish from selected tows were examined for maturity states (Beamish and Smith 1976).

Incidental catches of brown catshark (Apristurus brunneus) and eulachon (Thaleichthys pacificus) were examined for sex and measured for total length and fork length, respectively.

Water temperatures, from surface to bottom, were collected at selected stations with expendable bathythermographs (XBT).

RESULTS AND DISCUSSION

GENERAL SUMMARY

During March 19-30, a total of 26 midwater tows were completed in the Strait of Georgia from Mitlenatch Island to Saturna Island (Fig. 1). Detailed records of bridge-log information and species composition of catches by haul are contained in Appendix table 1. A list of the common and scientific names of all species reported is in Appendix table 2.

Results of the echogram survey (Fig. 2) indicated the presence of 2 distinct midwater layers. The concentration of each layer was determined subjectively using the procedure by Thompson and McFarlane (1982). The first midwater layer or the shallow spotting layer ranged from 27 to 165 m (15 to 90 fath). The density estimates ranged from nil, in the Texada Island vicinity and small localized areas in the central Strait, to heavy spotting, south of Texada Island (Fig. 3). The light spotting layer dominated the shallow layer during the survey.

The second layer or the main concentration is found deeper in the midwater ranging in depth from 100 to 476 m (55 to 260 fath). A subjective density estimate of the concentration ranged from nil, in small localized areas throughout the Strait, to very heavy off the Sandheads area, Halibut Bank and Cape Lazo (Fig. 4). During the survey the predominant density estimate used to describe the main concentration was medium. The most noticeable difference between the results of the echogram survey in 1983 (Shaw et al. 1985) and this survey was the presence of a very heavy scatter layer between Cape Lazo and north Texada Island which was not present in 1983. This concentration ranged in depth from 128-301 m (70-165 fath).

Most (88%) of the sets were made within the main concentration deeper than 135 m (74 fath). The remaining sets were made in the spotting layer at depths less than 106 m (58 fath).

The most abundant species caught during the survey was Pacific hake, with walleye pollock and spiny dogfish being common but less abundant. The total catch by principal species was:

Species	Weight (kg)	% total catch
Pacific hake	4,952	44.2
Walleye pollock	3,720	33.2
Spiny dogfish	2,493	22.2
Other[a]	43	0.4
Total	11,208	100.0

[a]Individual totals for other species were $\leq$1% of the total catch.

Water temperature profiles were recorded at 11 stations (Fig. 1). A summary of the temperature profile by depth interval is presented in Table 1. The mean surface temperature in the Strait of Georgia during the survey was 8.5°C, cooler than reported in 1983 by Shaw et al. (1985). Water temperatures shallower than 201 m were 4°C cooler than in 1983, however no difference from last year was noted deeper than 201 m.

PACIFIC HAKE

Pacific hake were sampled in 77% of the sets. A total of 4900 hake was measured for fork length. A summary of the biological samples collected is in Table 2.

Male hake composed 63% of the total hake catch (excluding unsexed fish) and dominated 58% of all sets.

Male hake ranged in size from 10 to 50 cm and females from 11 to 65 cm (Appendix table 3). The majority (86%) were adults ranging from 36 to 47 cm with less than 1% being larger than 50 cm. Two modal groups were evident at 14 cm (age 1+) and 40-41 cm (age 3 and older) (Fig. 5). Age 1+ fish accounted for 5% of the total catch and were present in 85% of the sets. Large catches of age 1+ fish were off Cape Lazo (set 3) at 165 m (90 fath) and off Halibut Bank area (sets 13, 21 and 26) at depths ranging from 166-183 m (90-100 fath). Very few age 2+ fish (24 cm) were caught during the survey accounting for only 1% of the total catch. Surveys by past workers (McFarlane et al. 1983 and Shaw et al. 1985) also observed the absence of age 2+ fish during the similar time period.

Age composition was determined from 362 paired otoliths collected from sets 2 and 12. Hake ranged from 1 to 14 yr (Table 3). Age 5+ and 6+ fish dominated the age composition representing the strong 1978 and 1979 year-classes. These results are consistent with those from the 1983 survey by Shaw et al. (1985) in which the 1978 and 1979 year-classes accounted for 50% of the age sample. Growth curves from this survey are consistent with those determined from previous cruises (Beamish et al. 1978a,b; Cass et al. 1978; McFarlane et al. 1982a,b, 1983; Shaw et al. 1985). Hake grow relatively rapidly to age 4, after which the rate of growth becomes reduced (Fig. 6). The mean lengths for age 4 males and females (38.2 cm and 40.1 cm,

respectively) are similar to the 1983 age results (Shaw et al. 1985). After age 4 mature females grew on the average 2.4 cm larger than mature males.

The maturity states of hake were examined from a total of 2818 fish. During the survey, hake were spawning with 25% of the males examined ripe and running (RR) (Table 4). Twenty-two percent of the males were ripe (R) and 22% were spent (S). Most of the females (39%) were ripe, 20% were ripening (R_2) and 19% were spent. The length at 50% maturity, from probit analysis (Leslie et al. 1945), was 30.0 cm for males and 33.8 cm for females (Fig. 7). These results are similar to those by Shaw et al. 1985. The length at 100% maturity for males was 35.0 cm and 39.0 cm for females. The age at 50% maturity, from probit analysis, was 3.0 yr for both males and females.

Individual round weights were recorded from 345 hake of which a total of 317 were in a pre-spawning state. The length-weight relationships are:

Males	$Wt(gm) = 0.1444\ (FL(cm))^{2.1257}$	n = 196
Females	$Wt(gm) = 0.0693\ (FL(cm))^{2.9802}$	n = 121
Sexes combined	$Wt(gm) = 0.0103\ (FL(cm))^{2.8486}$	n = 317

These relationships are similar to those obtained in 1981 during a similar time period (McFarlane et al. 1983).

A total of 104 hake were examined for stomach contents (Table 5). Approximately 90% of the stomachs were empty or everted. Those stomachs with food items contained mostly unidentifiable fish remains (47%) and euphausiids (35%).

WALLEYE POLLOCK

Walleye pollock were sampled in 81% of the sets. A total of 2096 pollock were measured for fork length and sexed. A summary of the biological samples collected is in Table 6.

Male pollock composed 73% of the total pollock catch and dominated 62% of all sets.

Male pollock ranged in length from 23 to 52 cm and 23 to 56 cm for female pollock (Appendix table 4). The majority (73%) of the fish were adults ranging from 36 to 42 cm. One size-class for males (mode at 40 cm) and one for females (made at 41 cm) was observed in the length frequency (Fig. 8). Pollock $\geq$50 cm accounted for 1.3% of the total catch with females attaining the larger size.

The maturity states of pollock were examined from a total of 1364 fish. Sixty-one percent of the males and 11% of the females were ripe and running (Table 7). Approximately 16% of the males were ripe and 16% were spent. Most (30%) of the females were ripening (R_2), 23% were already spent.

The length at 50% maturity was 29.0 cm for males and 31.0 cm for females (Fig. 9). The length at 100% maturity was 31.0 cm for males and 32.0 cm for females.

Stomach contents were examined from 47 pollock (Table 8). Seventy-two percent of the stomachs examined were either empty or everted. The principal component of the diet was amphipods, 42.3% by volume.

SPINY DOGFISH

Spiny dogfish were sampled in 81% of the sets. A total of 891 dogfish was measured for total length and sexed. A summary of the biological samples collected is in Table 9.

Male dogfish composed only 40% of the total dogfish catch and dominated 19% of all sets.

Dogfish ranged in length from 26-124 cm (Appendix table 5). Sixty-three percent of the dogfish were $\leq$60 cm (Fig. 10). Most of these fish were caught off Cape Lazo (set 4) at 106 m (58 fath). Adult dogfish (>60 cm) were found throughout the Strait with most caught off Halibut Bank.

Maturity state was determined from 158 dogfish (Table 10) of which the majority (59%) were immature. All of the mature males (47%) examined were in a ripe condition. Approximately 34% of the females were mature of which most contained yolk sac pups.

OTHER SPECIES SAMPLED

Brown cat shark and eulachon were sampled during the survey and a summary of the biological samples collected is presented in Table 11.

Brown cat shark were present in 5 of the 26 sets. The depth of capture ranged from 91 to 241 m (50 to 132 fath). Males composed 75% of the total catch and dominated 60% of the sets. A total of 32 brown cat shark were measured and sexed. Male brown cat shark ranged in total length from 45 to 55 cm and from 46 to 49 cm for females (Appendix table 6).

Eulachons were present in 3 of the 26 sets. The depth of capture ranged from 137 to 183 m (75 to 100 fath). Most of these fish were caught off East Mayne Island area. A total of 235 fish were measured and sexed. Male eulachon ranged in fork length from 13 to 21 cm and females ranged from 13 to 20 cm (Appendix table 7). Modal lengths of males (17-18 cm) were larger than for females (16 cm).

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Table 1. Water temperature (°C) by station and by depth using the XBT. R/V G.B. REED, March 19-30, 1984.

Stn. no.	Date	Location	Surface (°C)	Midwater (°C)				Bottom (°C)	depth (m)
				91 m	164 m	201 m	256 m		
A	20	49°02.5 123°26.6	8.6	8.5	8.4	8.5	9.0	9.4	344
B	20	49°13.0 123°28.3	8.4	8.4	8.5	9.0	9.3	9.5	311
C	20	49°14.5 123°37.3	8.3	8.4	8.6	8.6	9.0	9.5	380
D	20	49°19.5 123°48.4	8.5	8.3	8.6	9.1	9.3	9.5	371
E	21	49°25.4 124°04.9	8.5	8.7	9.1	9.5	9.6	9.8	380
F	21	49°38.7 124°13.4	8.6	8.7	9.4	9.4	9.5	9.6	368
G	21	49°46.7 124°45.3	8.6	9.0	9.0	9.1	9.4	9.8	360
H	21	49°56.8 125°04.8	8.5	8.8	9.0	9.0	9.3	9.4	282
I	22	49°35.4 124°27.2	8.6	8.7	8.8	8.8	9.3	9.4	263
J	22	49°25.6 124°22.0	8.5	8.8	8.7	9.2	9.5	9.6	355
K	22	48°50.8 123°10.0	8.7	8.4	8.4			8.7	194
Temperature range (°C)			8.3-8.7	8.3-9.0	8.4-9.4	8.5-9.5	9.0-9.6	8.7-9.8	
$\bar{X}$ temperature (°C)			8.5	8.6	8.8	9.0	9.3	9.5	

Table 2. Summary of the biological samples of Pacific hake. R/V G.B. REED, March 19-30, 1984.

Set no.	Average net depth (m)	Length			Maturity	Ovary wt.	Body wt.	Stomach contents	Paired otolith	Sampling remarks
		M	F	T						
1	216	312	3	315	198	-	-	-	95	Random
2	274	291	103	394	191	-	-	-	191	Random
3	165	29	6	66	-	-	-	-	-	T.C.[a]
4	106	0	13	13	-	-	-	-	-	T.C.
5	210	255	46	306	301	-	-	-	100	T.C.
6	230	118	72	190	190	16	180	-	-	T.C.
7	179	51	11	62	-	1	61	-	-	T.C.
9	238	305	16	322	213	4	44	-	-	Random
10	256	39	35	74	74	-	-	-	-	T.C.
12	241	197	282	479	281	-	-	-	183	Random
13	174	279	54	333	273	-	-	-	273	T.C.
15	137	3	1	4	4	-	-	-	-	T.C.
18	183	2	14	16	16	--	-	-	-	T.C.
19	91	334	6	340	120	-	-	-	-	T.C.
20	256	170	225	395	201	-	-	-	-	Random
21	166	392	38	430	206	-	-	24	100	Random
23	211	298	66	364	155	-	-	-	96	Random
24	247	137	205	342	129	9	60	-	-	Random
25	179	198	91	289	100	-	-	-	-	Random
26	183	133	33	166	166	-	-	80	-	T.C.
Total		3543	1320	4900	2818	30	345	104	1038	

[a]T.C. = Total catch sampled.

Table 3. Mean size of Pacific hake for each age-class in set numbers 2 and 12. R/V G.B. REED, March 19-30, 1984.

	Male			Female			Total		
Age	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	N
1	13.5	0.00	1	14.2	0.00	1	13.9	0.49	2
2	0.0	0.00	0	28.1	0.00	1	28.1	0.00	1
3	35.8	1.66	11	38.1	1.27	2	36.2	1.78	13
4	38.2	1.63	20	40.1	1.29	14	39.0	1.76	34
5	39.4	2.01	35	41.8	1.55	38	40.7	2.13	73
6	40.6	1.89	62	41.4	2.41	47	40.9	2.16	109
7	41.4	1.49	20	43.6	1.70	22	42.5	1.93	42
8	42.8	2.23	11	45.5	2.68	14	44.4	2.80	25
9	43.9	1.28	16	47.4	3.90	5	44.8	2.56	21
10	44.0	1.59	11	45.3	2.31	7	44.5	1.95	18
11	44.4	1.49	10	49.9	4.46	3	45.7	3.28	13
12	44.8	1.99	4	47.0	0.00	1	45.2	1.99	5
13	0.0	0.00	0	49.0	4.24	2	49.0	4.24	2
14	45.0	3.46	3	46.0	0.00	1	45.3	2.87	4
Total			204			158			362

Table 4. Pacific hake maturity frequency. R/V G.B.REED, March 19-30, 1984.

SET NO.	1			2			5			6		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	1	2	3	1	1	2	3	2	5
I2	2	-	2	1	2	3	1	0	1	1	0	1
R1	34	-	34	13	0	13	5	0	5	9	0	9
R2	89	-	89	72	3	75	95	0	95	38	7	45
R	57	-	57	51	20	71	98	25	123	36	26	62
1R	0	-	0	0	2	2	0	1	1	0	1	1
2R	0	1	1	0	8	8	0	7	7	0	18	18
RR	12	-	12	6	6	12	39	7	46	30	10	40
S	3	-	3	1	3	4	16	5	21	1	8	9
Rb	-	-	-	-	-	-	-	-	-	-	-	-
Rc	-	-	-	-	-	-	-	-	-	-	-	-
Rt	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	197	1	198	145	46	191	255	46	301	118	72	190

SET NO.	9			10			12			13		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	2	2	4	3	3	6	1	-	1	19	22	41
I2	2	0	2	2	0	2	1	-	1	10	2	12
R1	12	0	12	1	0	1	5	-	5	18	0	18
R2	38	3	41	0	3	3	9	3	12	13	0	13
R	67	4	71	20	18	38	32	74	106	22	3	25
1R	0	0	0	0	0	0	1	0	1	0	0	0
2R	0	1	1	0	4	4	0	53	53	0	0	0
RR	47	2	49	10	0	10	35	8	43	77	2	79
S	32	1	33	3	7	10	31	27	58	74	10	84
Rb	-	-	-	-	-	-	0	-	0	0	-	0
Rc	-	-	-	-	-	-	1	-	1	1	-	1
Rt	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	200	13	213	39	35	74	116	165	281	234	39	273

Table 4 (cont'd)

SET NO.	15			18			19			20		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	2	5	7	4	2	6	2	2	4
I2	-	-	-	-	0	0	4	0	4	3	3	6
R1	-	-	-	-	0	0	3	0	3	8	1	9
R2	-	-	-	-	0	0	0	0	0	8	6	14
R	-	-	-	-	1	1	4	1	5	23	56	79
1R	-	-	-	-	0	0	0	-	0	0	0	0
2R	-	-	-	-	1	1	0	-	0	0	20	20
RR	1	-	1	-	0	0	71	-	71	14	0	14
S	2	1	3	-	7	7	31	-	31	31	24	55
Rb	-	-	-	-	-	-	-	-	-	-	-	-
Rc	-	-	-	-	-	-	-	-	-	-	-	-
Rt	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	3	1	4	2	14	16	117	3	120	89	112	201

SET NO.	21			23			24			25		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	12	5	17	1	1	2	5	9	14	2	2	4
I2	0	0	0	0	0	0	0	1	1	0	0	0
R1	1	0	1	5	0	5	1	0	1	0	0	0
R2	2	0	2	1	0	1	3	0	3	4	0	4
R	7	1	8	14	8	22	3	37	40	13	14	27
1R	0	0	0	0	0	0	0	1	1	0	0	0
2R	0	2	2	0	4	4	1	15	16	0	12	12
RR	84	1	85	41	3	44	6	5	11	25	1	26
S	83	7	90	65	12	77	24	15	39	20	7	27
Rb	0	-	0	-	-	-	-	2	2	-	-	-
Rc	0	-	0	-	-	-	-	0	0	-	-	-
Rt	1	-	1	-	-	-	-	1	1	-	-	-
TOTAL	190	16	206	127	28	155	43	86	129	64	36	100

Table 4 (cont'd)

SET NO.	26			TOTAL		
GONAD MATURITY STAGE	M	F	T	M	F	T
I1	14	20	34	72	78	150
I2	13	1	14	40	9	49
R1	25	0	25	140	1	141
R2	7	0	7	379	25	404
R	9	4	13	456	292	748
1R	0	0	0	1	5	6
2R	0	0	0	1	146	147
RR	29	0	29	527	45	572
S	36	8	44	453	142	595
Rb	-	-	-	0	2	2
Rc	-	-	-	2	0	2
Rt	-	-	-	1	1	2
TOTAL	133	33	166	2072	746	2818

Table 5. Pacific hake stomach contents. R/V G.B. REED, March 19-30, 1984.

Number examined	104	
Number empty	52	
Number everted	42	
Food items	**Volume (cc)**	**%**
Leuroglossus	1.5	10.3
Fish remains (unid)	6.8	46.6
Euphausiid	5	34.5
Glass shrimp	1.3	8.6
Total	14.5	

Table 6. Summary of the biological samples of walleye pollock. R/V G.B. REED, March 19-30, 1984.

Set no.	Average net depth (m)	Length			Maturity	Stomach contents	Pectoral fins	Sampling remarks
		M	F	T				
1	216	31	3	34	-	-	-	T.C.[a]
2	274	15	16	31	-	-	-	T.C.
3	165	26	10	36	-	-	-	T.C.
4	106	0	14	14	-	-	-	T.C.
5	210	13	10	23	23	-	-	T.C.
6	230	4	1	5	5	-	-	T.C.
9	238	7	6	13	13	-	-	T.C.
10	256	0	2	2	-	-	-	T.C.
12	241	21	19	40	40	-	-	T.C.
13	174	234	52	286	175	-	175	T.C.
14	137	362	7	369	192	-	194	Random
15	137	289	95	384	181	-	94	Random
17	165	225	37	262	169	-	-	Random
18	183	147	211	358	267	20	93	Random
19	91	91	41	132	132	-	-	T.C.
20	256	17	11	28	28	-	-	T.C.
21	166	2	0	2	-	-	-	T.C.
23	211	14	8	22	22	-	-	T.C.
24	247	8	8	16	16	-	-	T.C.
25	179	7	5	12	12	-	-	T.C.
26	183	21	6	27	27	27	-	T.C.
Total		1534	562	2096	1364	47	556	

[a]T.C. = Total catch sampled.

Table 7. Walleye pollock maturity frequency. R/V G.B. REED, MARCH 19-30, 1984.

SET NO.	5			6			7			9		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	2	8	10	-	-	-
I2	-	1	1	-	-	-	8	1	9	-	-	-
R1	-	0	0	-	-	-	2	0	2	-	1	1
R2	-	0	0	-	-	-	10	0	10	-	0	0
R	8	1	9	2	1	3	22	2	24	2	1	3
1R	0	1	1	0	-	0	0	-	0	0	0	0
2R	0	4	4	0	-	0	0	-	0	0	1	1
RR	4	2	6	2	-	2	7	-	7	5	1	6
S	1	1	2	-	-	-	-	-	-	-	1	1
Rb	-	-	-	-	-	-	-	-	-	-	0	0
Rc	-	-	-	-	-	-	-	-	-	-	0	0
Rt	-	-	-	-	-	-	-	-	-	-	1	1
TOTAL	13	10	23	4	1	5	51	11	62	7	6	13

SET NO.	12			13			14			15		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	-	-	-	-	-	-
I2	-	1	1	-	-	-	-	1	1	1	-	1
R1	-	1	1	1	-	1	-	0	0	0	-	0
R2	-	2	2	16	-	16	4	0	4	0	-	0
R	5	7	12	58	7	65	6	1	7	3	10	13
1R	0	1	1	0	2	2	1	0	1	0	0	0
2R	0	7	7	0	9	9	0	0	0	0	9	9
RR	14	-	14	45	6	51	137	0	137	90	16	106
S	2	-	2	19	5	24	40	1	41	35	16	51
Rb	-	-	-	0	0	0	-	0	0	-	0	0
Rc	-	-	-	1	1	2	-	1	1	-	1	1
Rt	-	-	-	-	5	5	-	-	-	-	-	-
TOTAL	21	19	40	140	35	175	188	4	192	129	52	181

Table 7 (cont'd)

SET NO.	17			18			19			20		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	-	-	-	-	-	-	-	-	-
I2	-	-	-	-	1	1	2	-	2	3	2	5
R1	-	-	-	-	0	0	0	-	0	1	0	1
R2	6	-	6	-	0	0	4	-	4	0	0	0
R	14	1	15	11	20	31	15	7	22	2	3	5
1R	0	0	0	0	2	2	0	0	0	0	0	0
2R	0	13	13	0	47	47	0	22	22	0	3	3
RR	100	4	104	82	10	92	54	2	56	9	2	11
S	24	5	29	17	58	75	13	3	16	2	0	2
Rb	-	0	0	-	2	2	0	1	1	-	0	0
Rc	-	1	1	-	10	10	0	0	0	-	0	0
Rt	-	1	1	-	7	7	3	6	9	-	1	1
TOTAL	144	25	169	110	157	267	91	41	132	17	11	28

SET NO.	23			24			25			26		
GONAD MATURITY STAGE	M	F	T	M	F	T	M	F	T	M	F	T
I1	-	-	-	1	-	1	-	-	-	-	-	-
I2	-	-	-	0	2	2	-	-	-	-	-	-
R1	-	-	-	0	0	0	-	-	-	-	-	-
R2	-	-	-	0	0	0	-	-	-	-	-	-
R	1	2	3	0	0	0	1	2	3	-	-	-
1R	0	0	0	0	1	1	0	0	0	-	-	-
2R	0	3	3	0	0	0	0	2	2	-	-	-
RR	12	0	12	6	2	8	5	0	5	20	-	20
S	1	0	1	1	0	1	1	0	1	1	1	2
Rb	-	0	0	-	0	0	-	0	0	-	0	0
Rc	-	0	0	-	0	0	-	0	0	-	0	0
Rt	-	3	3	-	3	3	-	1	1	-	5	5
TOTAL	14	8	22	8	8	16	7	5	12	21	6	27

Table 7 (cont'd)

SET NO. GONAD MATURITY STAGE	TOTAL		
	M	F	T
I1	3	8	11
I2	14	9	23
R1	4	2	6
R2	40	2	42
R	150	65	215
1R	1	7	8
2R	0	120	120
RR	592	45	637
S	157	91	248
Rb	0	3	3
Rc	1	14	15
Rt	3	33	36
TOTAL	965	399	1364

Table 8. Walleye pollock stomach contents. R/V G.B. REED, March 19-30, 1984.

Number examined	47	
Number empty	32	
Number everted	2	
Food items	**Volume (cc)**	**%**
Amphipod	2.8	42.3
Euphausiid	1.3	19.2
Glass shrimp	1.5	23.1
Tromopterus worm	1	15.4
Total	6.5	

Table 9. Summary of the biological samples of spiny dogfish. R/V G.B. REED, March 19-30, 1984.

Set no.	Average net depth (m)	Length			Maturity	Sampling remarks
		M	F	T		
1	216	17	46	63	-	T.C.[a]
2	274	18	17	35	-	T.C.
3	165	26	14	40	40	T.C.
4	106	104	114	218	-	T.C.
5	210	33	25	58	-	T.C.
6	230	19	27	46	-	T.C.
7	179	1	14	15	15	T.C.
9	238	28	28	56	56	T.C.
10	256	2	12	14	14	T.C.
11	232	2	31	33	33	T.C.
12	241	6	53	59	-	T.C.
13	174	17	15	32	-	T.C.
14	137	0	3	3	-	T.C.
17	165	2	6	8	-	T.C.
19	91	19	19	38	-	T.C.
20	256	9	13	22	-	T.C.
21	166	14	38	52	-	T.C.
23	211	3	14	17	-	T.C.
24	247	14	15	29	-	T.C.
25	179	1	12	13	-	T.C.
26	183	18	22	40	-	T.C.
Total		353	538	891	158	

[a]T.C. = Total catch sampled.

Table 10. Spiny dogfish maturity frequency by haul. R/V G.B. REED, March 19-30, 1984.

Gonad maturity stage	Set number											
	3		7		9		10		11		Total	
	M	F	M	F	M	F	M	F	M	F	M	F
I_1	15		1		10	-	2		-		28	
I_2	1		-		2	-	-		-		3	
R	10		-		6	-	-		2		28	
I_1D_1	-	12	-	1	-	10	-	5	-	1	-	29
I_1D_2	-	2	-	1	-	3	-	0	-	0	-	6
R_1D_1	-	-	-	0	-	1	-	0	-	0	-	1
R_1D_2	-	-	-	0	-	5	-	1	-	3	-	9
R_1D_3	-	-	-	0	-	2	-	0	-	1	-	3
R_1D_5	-	-	-	5	-	1	-	1	-	2	-	9
R_2D_2	-	-	-	0	-	0	-	0	-	1	-	1
R_2D_5	-	-	-	1	-	1	-	0	-	3	-	5
R_2D_6	-	-	-	2	-	0	-	0	-	0	-	2
R_3D_4	-	-	-	0	-	1	-	1	-	5	-	7
R_3D_5	-	-	-	0	-	0	-	1	-	1	-	2
R_3D_6	-	-	-	4	-	4	-	3	-	13	-	24
R_3D_8	-	-	-	-	-	-	-	-	-	1	-	1
Total	26	14	1	14	28	28	2	12	2	31	59	99

Table 11. Summary of the biological samples of brown cat shark and eulachon. R/V G.B. REED, March 19-30, 1984.

Species	Set no.	Length M	Length F	Length T	Sampling remarks
Brown cat shark	9	8	0	8	T.C.[a]
	12	5	0	5	T.C.
	13	2	5	7	T.C.
	18	0	1	1	T.C.
	19	9	2	11	T.C.
	Total	24	8	32	
Eulachon	14	18	24	42	T.C.
	15	96	82	178	T.C.
	18	9	6	15	T.C.
	Total	123	112	235	

[a]T.C. = Total catch sampled.

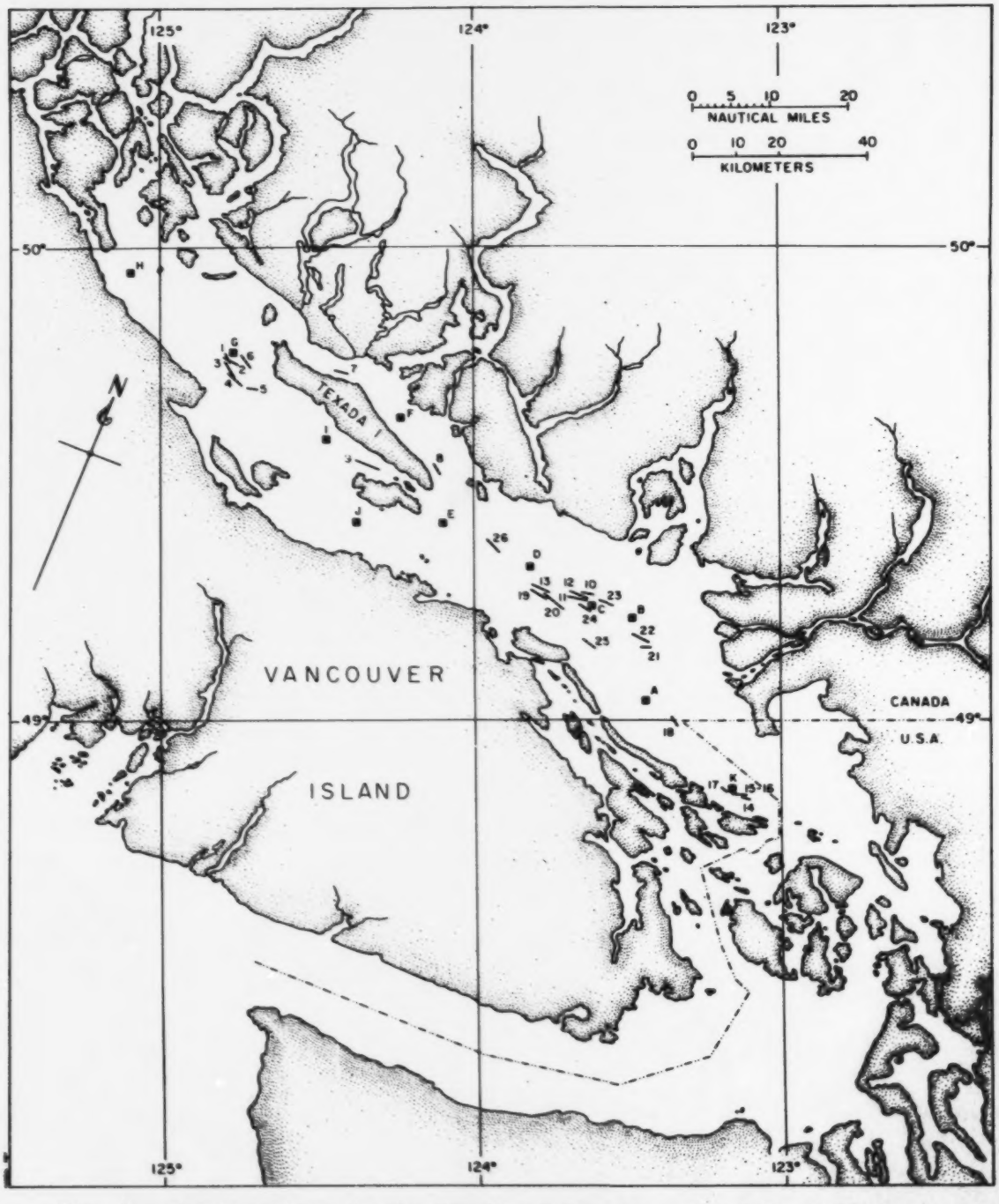

Fig. 1. Set locations in the Strait of Georgia. R/V G.B. REED, March 19-30, 1984. (XBT stations denoted by black square.)

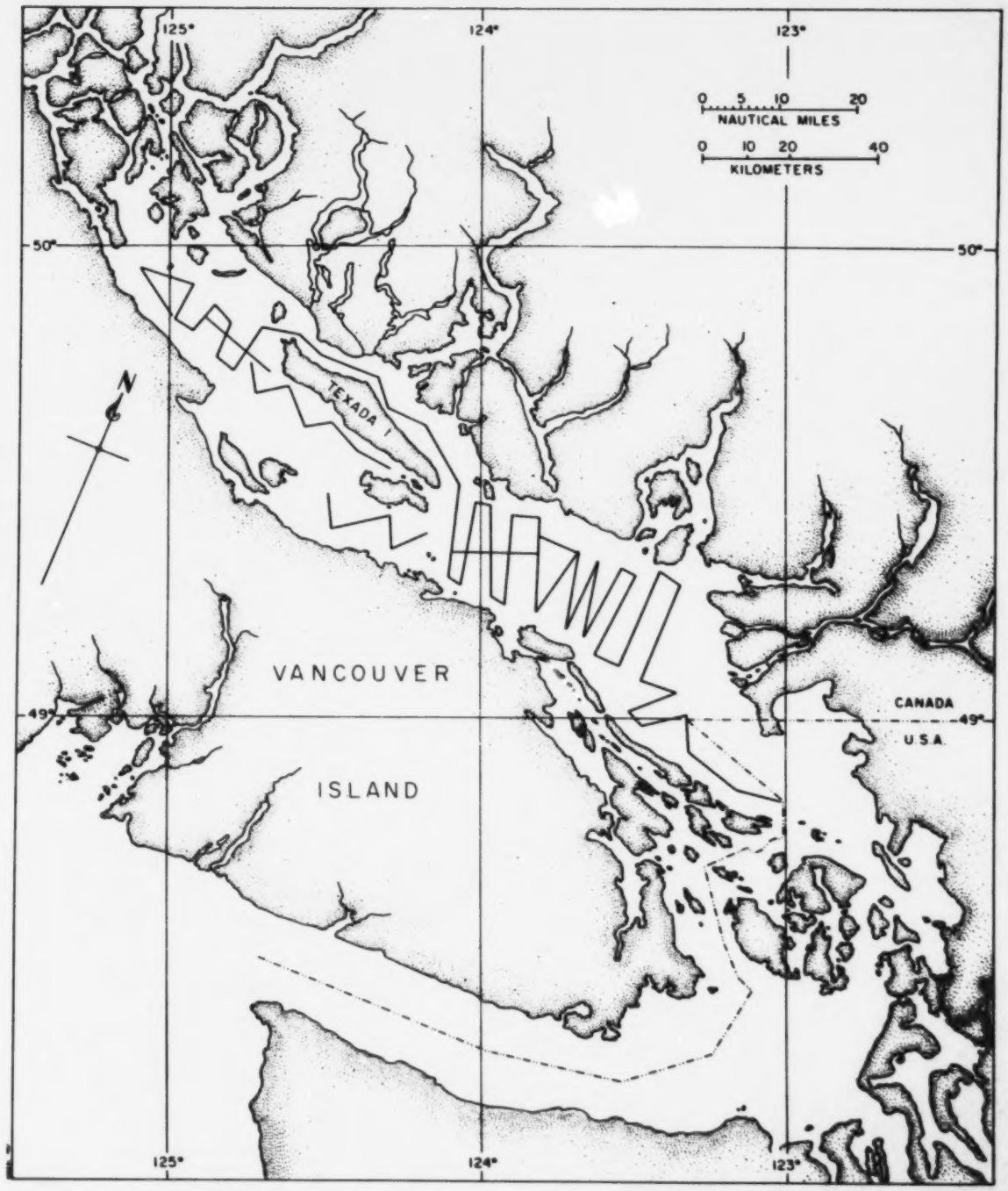

Fig. 2. Echo-sounding survey trackline travelled by the R/V G.B. REED in the Strait of Georgia, March 19-30, 1984.

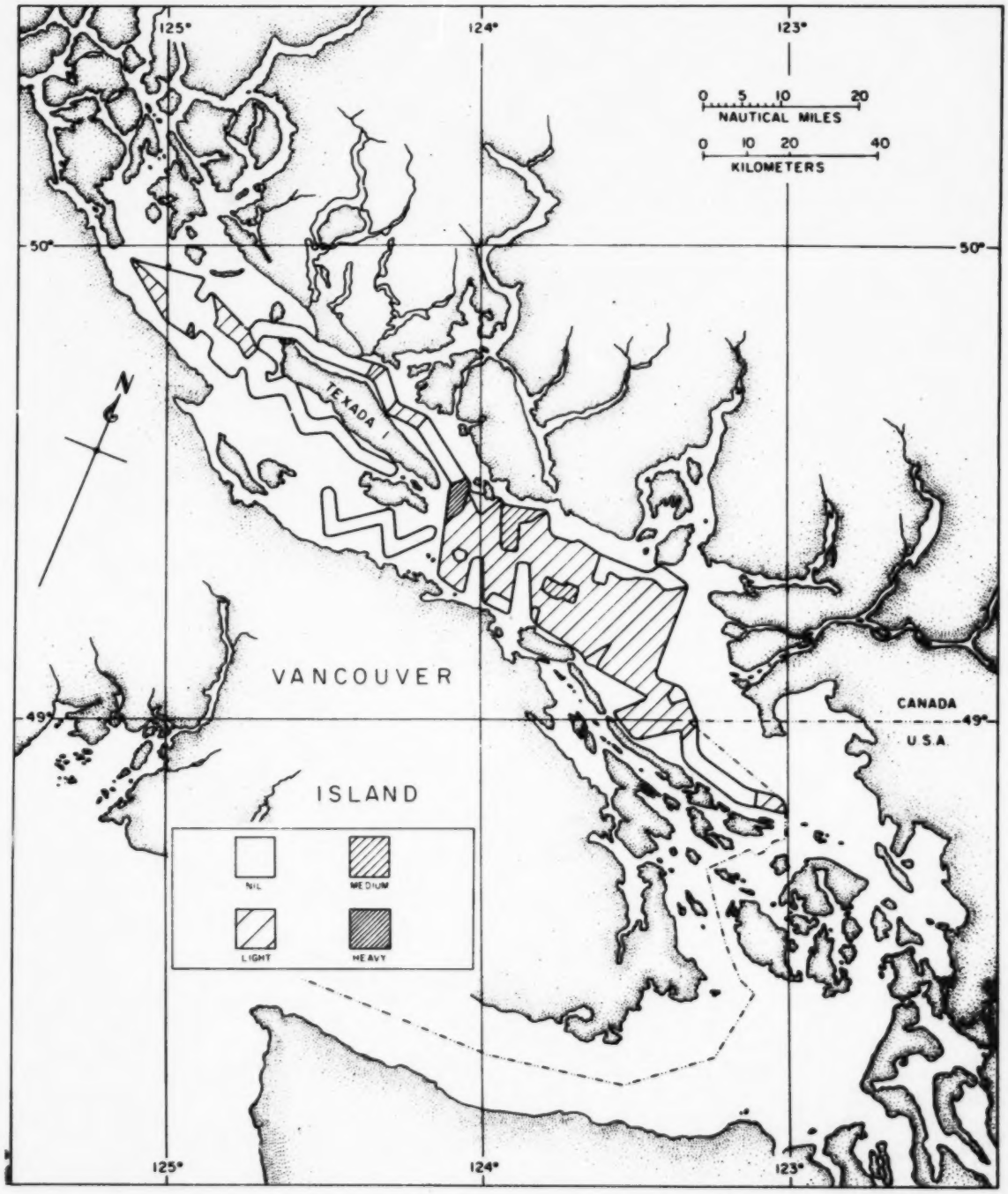

Fig. 3. Fish distribution in the shallow spotting layer in the Strait of Georgia as represented by echogram estimates of volume density. March 19-30, 1984.

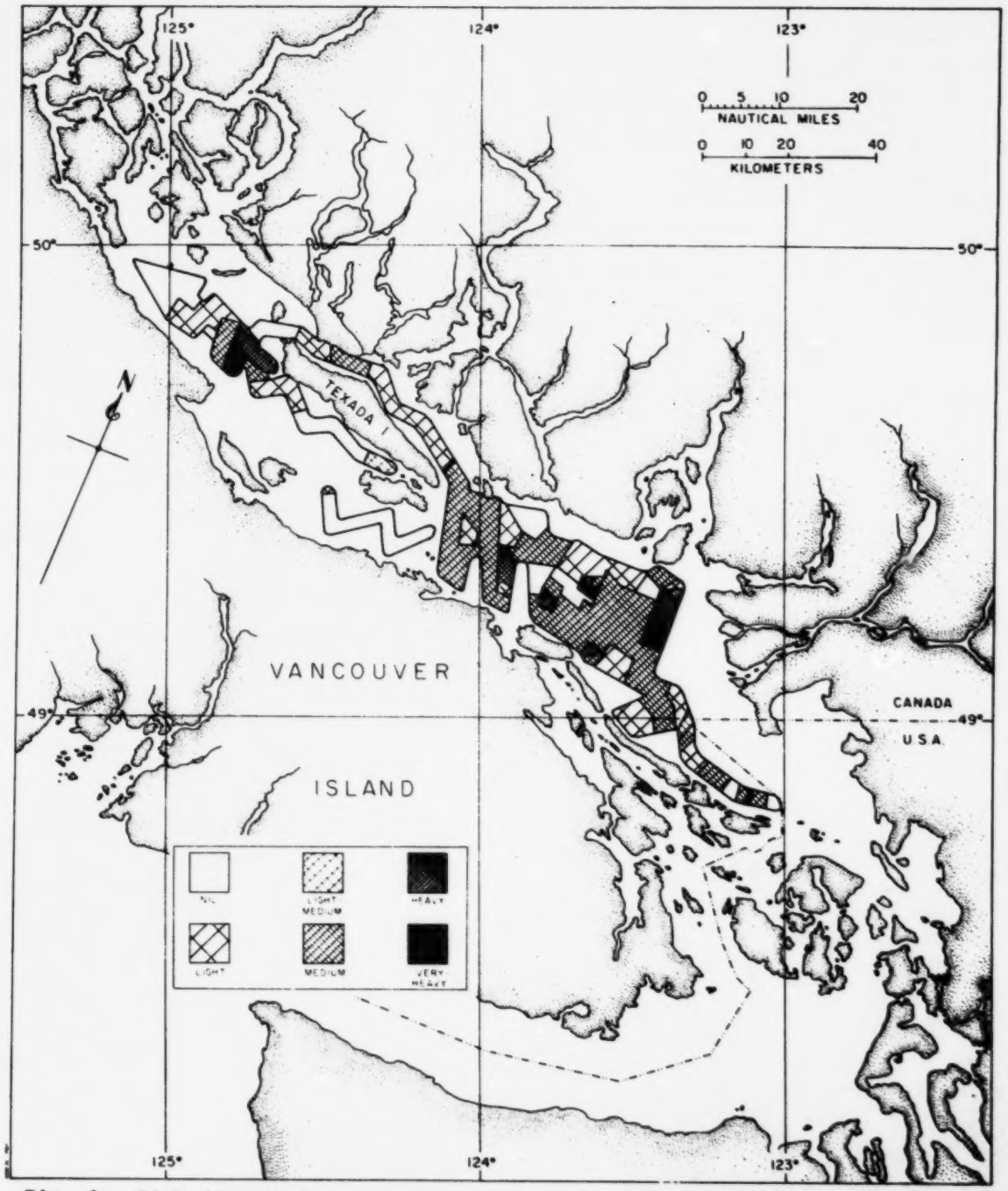

Fig. 4. Fish distribution in the main concentration layer in the Strait of Georgia as represented by echogram estimates of volume density. March 19-30, 1984.

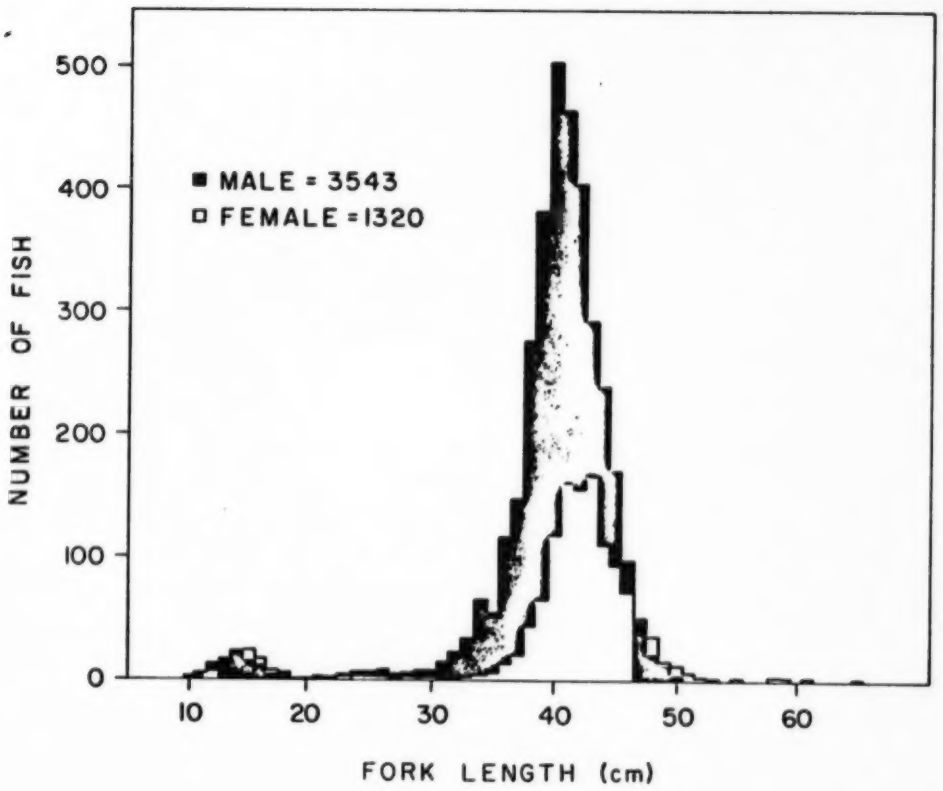

Fig. 5. Pacific hake length frequency by sex. R/V G.B. REED, March 19-30, 1984.

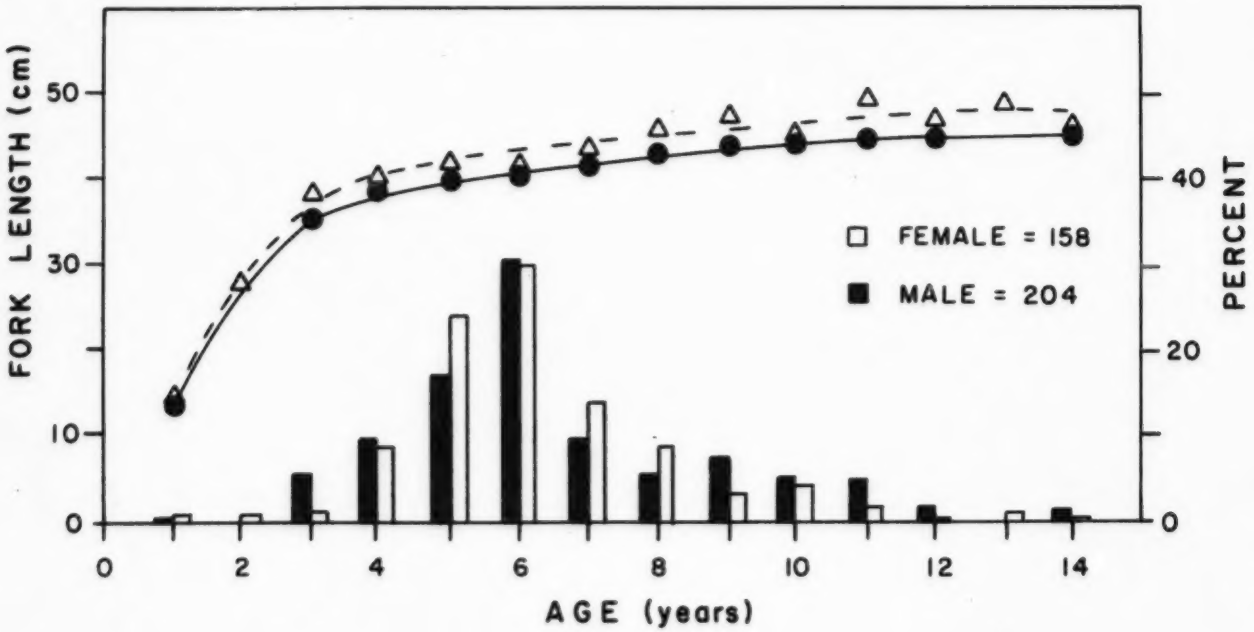

Fig. 6. Pacific hake age frequency and growth curves (fitted by eye) by sex sampled from sets 2 and 12. R/V G.B. REED, March 19-30, 1984.

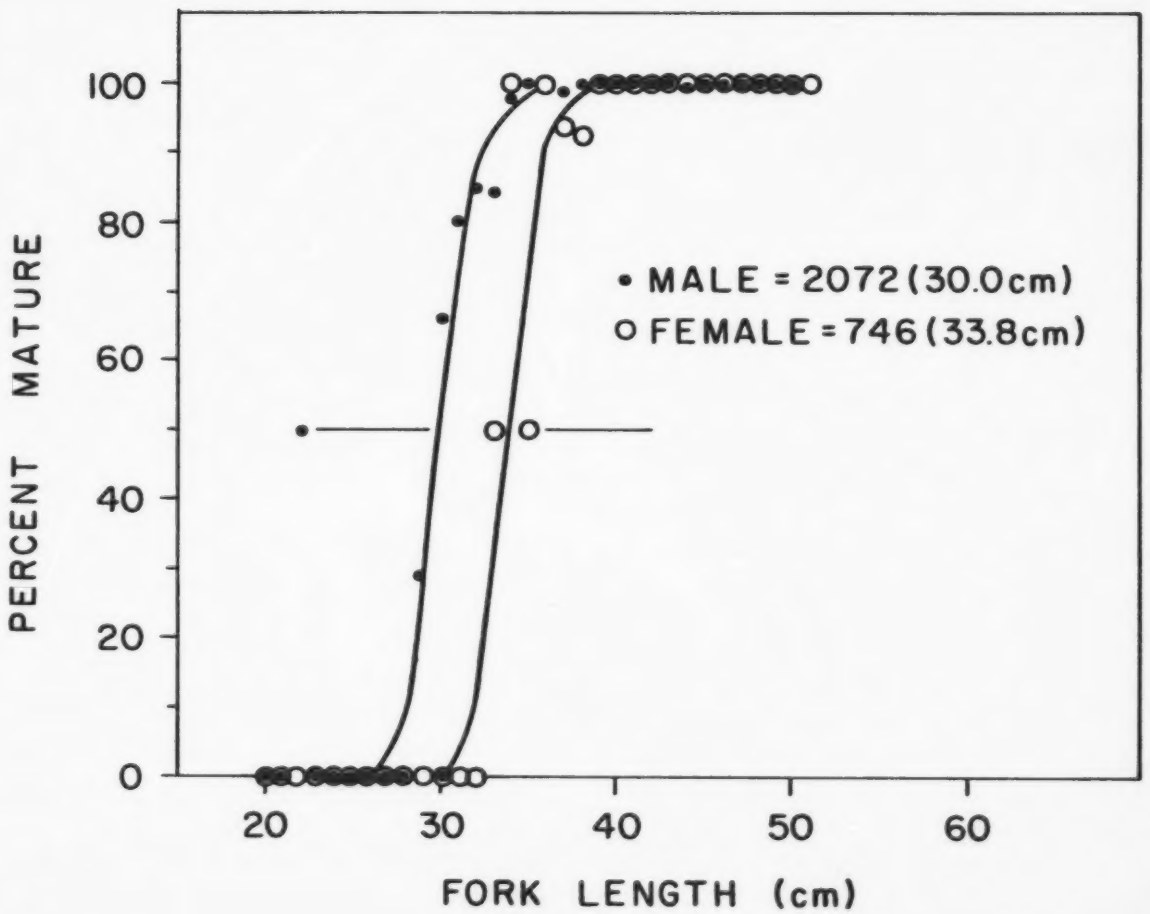

Fig. 7. Pacific hake maturity ogives (length at 50%) by sex. R/V G.B. REED, March 19-30, 1984.

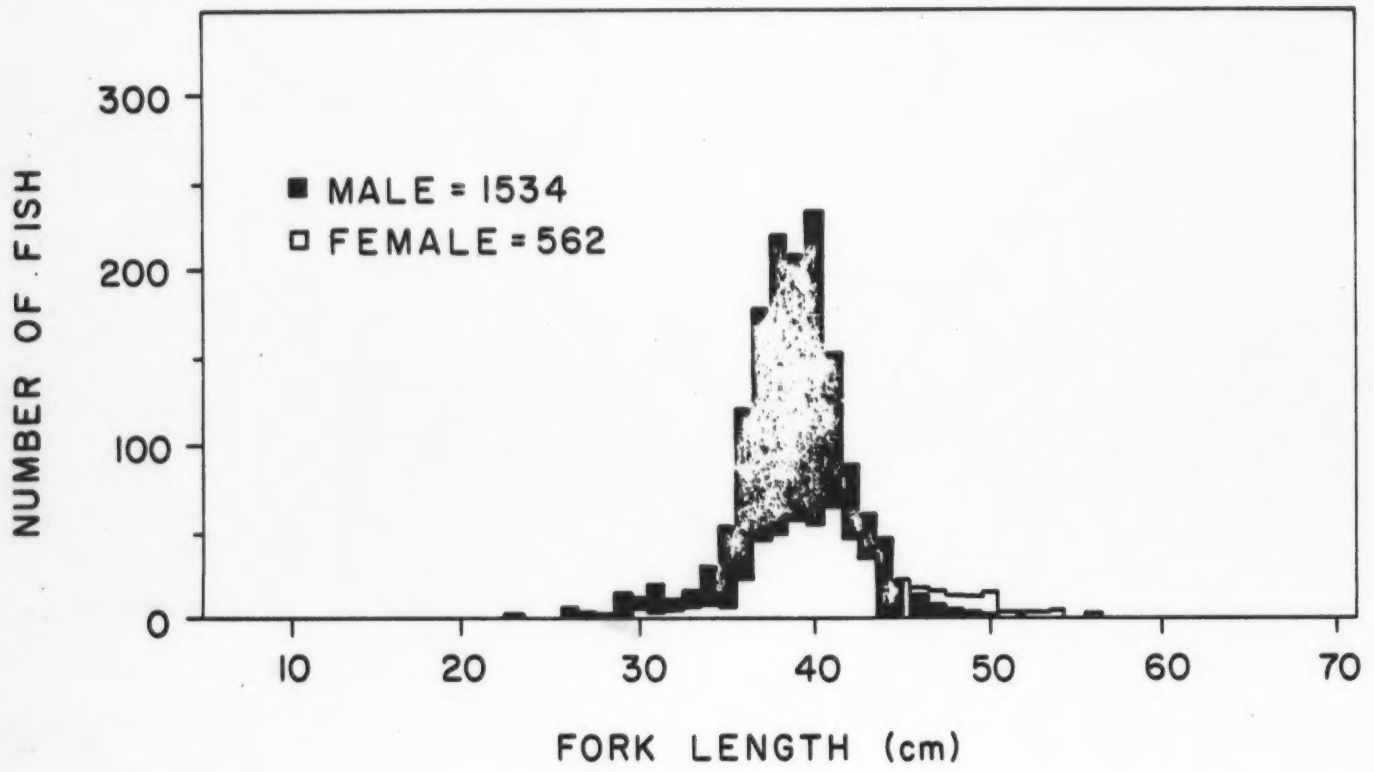

Fig. 8. Walleye pollock length frequency by sex. R/V G.B. REED, March 19-30, 1984.

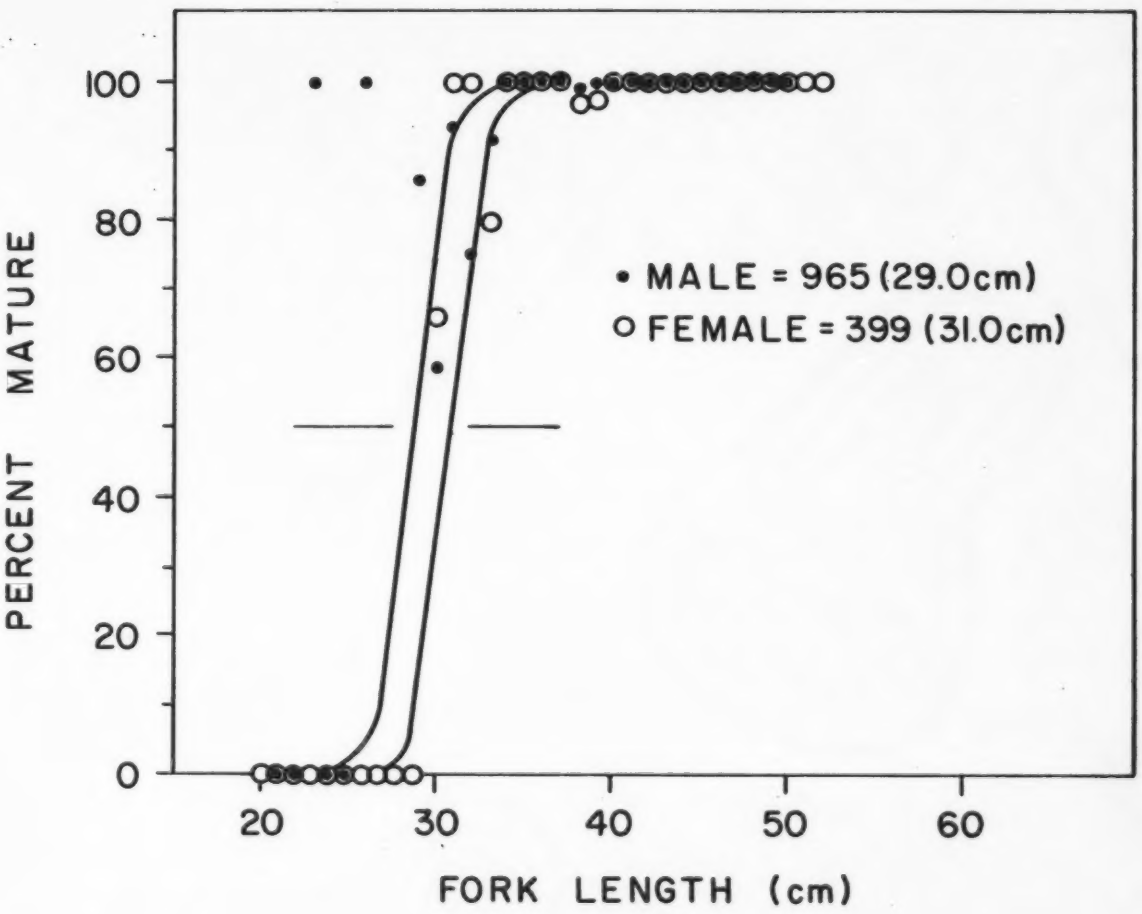

Fig. 9. Walleye pollock maturity ogives (length at 50%) by sex. R/V G.B. REED, March 19-30, 1984.

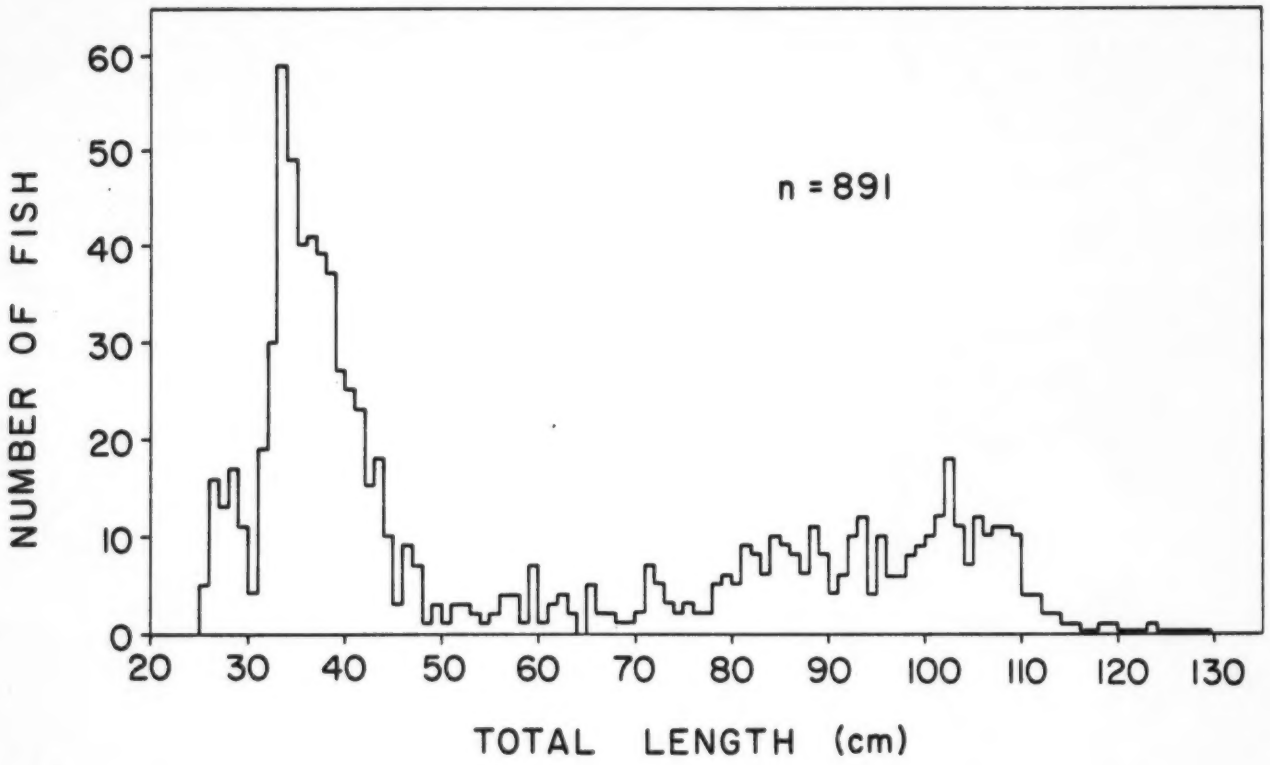

Fig. 10. Spiny dogfish length frequency. R/V G.B. REED, March 19-30, 1984.

Appendix table 1 through Appendix table 7 do not appear in paper, but appear in microfiche form at the back of this report.